**TREMATODES**

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| **FLUKES:** | ***Schistosoma mansoni***  **Direct Contact** | Schistosoma japonicum Direct Contact | Schistosoma haematobium Direct Contact |
| **English Name** | Blood Fluke | Blood Fluke | Blood Fluke |
| **Mode of transmission and the infective form** | Cercariae **directly infect** via skin  (hyaluronidase virulence factor) | Cercariae **directly infect** via skin  (hyaluronidase virulence factor) | Cercariae **directly infect** via skin  (hyaluronidase virulence factor) |
| **Life Cycle** | * Adults live 20-30 yrs; “eggs” released (100s-1000s/day) migrate into intestinal lumen or bladder. “Eggs” produce proteases allowing tissue migration. ~50% “eggs” die within host tissue and account for most pathology. * Infection to humans by water-born cercaria   + eggs/feces go to water; larva infects snail (limited # of snail species are hosts—limits geographic distribution); snail releases cercariae; they infect us via skin & disseminate * Transition from cercaria to schistosomulae in human(~2 days) * hyaluronidase helps in skin penetration; * tegument takes up host components including RBC antigens, HLA, Ig; “molecular mimicry” * Adult in **mesenteric veins**; | * **See S. mansoni** * Adult in **mesenteric veins** * **schisto in venus plexus**   + schistosome in mesenteric vein | * **See. S. mansoni** * Adult in **bladder veins**; |
| **Migration w/in Humans** | * Penetrates skin 🡪 change into schistosomulum (cercaria loses tail; fresh H­2O to salt H2O; glycolysis to fermentation; tegument takes up human Ags for evasion) 🡪 Blood 🡪 Lung 🡪 Liver veins * Schistosomulum feeds on plasma and eventually mates in the liver as an adult | Same as *S. mansoni* | Same as *S. mansoni* except bladder veins instead of mesenteric veins |
| **How is pathology produced?** | * Eggs released in **mesenteric veins** migrate to **intestinal** lumen (proteases help migration) * Pathology caused largely by eggs that can’t get out   + >50% of eggs will deposit into tissues and die causing chronic fibrosis of organs/blood vessels   + inflammatory responses to eggs that die in the tissues   + eggs can induce granuloma formation * Portal/pulmonary hypertension w/ collateral circulation, ascites, esophageal varices (which can rupture), liver fibrosis—pipestem fibrosis (Longitudinal sections of portal canals in which there is a great increase in the amount of fibrous tissue around the vessels and bile ducts) | Same as *S. mansoni* | * **hematuria in early disease** * eventual fibrosis of bladder & obstructive uropathy * rarely renal failure and hydronephrosis * rarely bladder carcinoma * Eggs released in bladder veins migrate to **bladder** lumen (see hematuria early) * 50% of eggs will deposit into tissues and die causing chronic fibrosis of organs and blood vessels * Bladder fibrosis, obstructive uropathy, renal failure/carcinoma |
| **Diagnosis –** What sample? What is seen? | * Deposited egg w/in **feces**   + **Lateral** spine * 🡨cercaria—motile larvae * Eosinophilia * Liver Ultrasound * Immunodx: ELISA, IFAT, RIA, IHA (indir hemoagglutination) | * Deposited egg w/in **feces and urine**   + **No** spine/ Lateral **small** spin     - **C:\Users\ccortes\Desktop\sj2.jpg** * Eosinophilia * Liver Ultrasound * Immunodx: ELISA, IFAT, RIA, IHA (indirect hemoagglutination) | * Deposited egg w/in **urine** (& some in feces)   + **Terminal** spine * Eosinophilia * Immunodx: ELISA, IFAT, RIA, IHA (indirect hemoagglutination) |
| **Definitive host** | Humans & Water Birds | Humans & Water Birds | Humans & Water Birds |
| **Intermediate host(s)** | Water Snail | Water Snail | Water Snail |
| **Form transmitted from human to next host** | Eggs from human waste hatch in water 🡪 Miracidia released infects mollusk | Eggs from human waste hatch in water 🡪 Miracidia released infects mollusk | Eggs from human waste hatch in water 🡪 Miracidia released infects mollusk |
| **Geographical foci** | Mainly in Africa and S. America (brazil) | SE Asia, Indonesia, Philippians | Tropical Africa, Middle East |
| **Treatment/Prevention** | * Sanitation; snail reduction; reducing carrier population (cause a lot of spread!) * Avoid swimming or wading in freshwater (oceans and chlorinated water is safe) * Drink safe/boiled water * Praziquantal (PZQ) * Oxamniquine (OXQ) | * Sanitation; snail reduction; reducing carrier population (cause a lot of spread!) * Avoid swimming or wading in freshwater (oceans and chlorinated water is safe) * Drink safe/boiled water * Praziquantal * Oxamniquine (OXQ) | * Sanitation; snail reduction; reducing carrier population (cause a lot of spread!) * Avoid swimming or wading in freshwater (oceans and chlorinated water is safe) * Drink safe/boiled water * Praziquantal * Oxamniquine (OXQ) |

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| **FLUKES:** | Fasciola hepatica INGESTION | ***Paragonimus westermani***  **INGESTION** | ***Cercarial dermatitis (schistosoma)***  **CONTACT—WRONG HOST** |
| **English Name** | Liver Fluke (sheep) | Lung fluke | Bird Schistosomes (Fluke) |
| **Mode of transmission and the infective form** | Encysted cercariae (metacercariae) on water plants/crabs/etc are eaten.  Eating undercooked/raw vegetables | Eating undercooked/raw infected crustaceans  Metacercariae are the infective form | Cercariae **directly infect** via skin |
| **Life Cycle** | * Indirect; **hermaphrodite**   + Liver: adult in bile duct; eggs/feces go to water; larva infects snail; snail releases cercariae that encyst on plants/crabs/etc; we eat these   + Lung: same except adult is in lung so see eggs in sputum or feces (ie, if sputum is swallowed) | * Umembryonated eggs released in feces or sputum🡪 eggs embryonate in water 🡪 miracidia hatch and penetrate crustaceans 🡪 develop into circariae in snail🡪 invades and encysts into metacercariae🡪 Humans infest inadequately cooked or pickled crustaceans that are infected🡪tissue invasions w/ migration to lungs where adults mature (65-90 days)🡪 lay eggs in cystic cavities in lungs which are excreted in sputum   + Eggs in sputum may be swallowed and passed in feces | * Indirect; **separate sexes** * **Female w/in Male canal**   + Involves mollusks and water birds; humans accidental hosts for cercariae |
| **Migration w/in Humans** | * Liver: larvae hatch in small intestine and penetrate GI wall; disseminate into blood, migrate to liver and penetrate capsule; go to biliary duct * Lung: same thing but end up in lung cavity |  | * Fail to form functional schistosomulum * Die in skin 🡪 inflammation! |
| **How is pathology produced?** | * Acute: diarrhea, abdominal pain, fever, vomiting, enlarged liver * Chronic: intermittent blockage of the bile duct and inflam | * **Acute** (invasion and migration); diarrhea, abdominal pain, fever cough, pulmonary abnormalities, eosinophilia * **Chronic:** pulmonary manifestations (cough, discolored sputum (expectorated clusters of reddish brown eggs, not blood), radiographic abnormalities (pseudeotubercules), may persist for 20 yrs   + In lung may be confused w/ Tb | * Cercariae penetrate skin (pin prick), fail to form functional schistosomulum and die 🡪 inflamm rxn (small red spot w/in 30 min)🡪 ↑ in size in the next day🡪 resolves within a week (treatable w/ anti-inflamm) |
| **Diagnosis –** What sample? What is seen? | * Unembryonated eggs in feces * C:\Users\ccortes\Desktop\F_hepatica_egg_wtmt_HB1.jpg * Eosinophilia * Adult * images.jpeg | * Eggs in stool/sputum (not present until 2-3 mo after infection) * C:\Users\ccortes\Desktop\Paragonimus_egg_wtmt.jpgellipsoidal * Immunodx—diff paragonimiasis from TB in Indochinese immigrants | * Severe dermatitis w/skin scraping showing cercariae |
| **Definitive host** | Humans and other mammals | Humans | Water Birds & sort of humans (dead-end) |
| **Intermediate host(s)** | Water snail | crustaceans | Water snail |
| **Form transmitted from human to next host** | Eggs in human feces hatch 🡪 Miracidium 🡪 penetrates snail | Eggs in human feces hatch 🡪 Miracidia 🡪 penetrates snail | Humans are dead-end hosts  Serious prob locally for swimmers in ponds, quarries etc. esp near shore |
| **Geographical foci** | Worldwide  In areas where sheep and cattle are raised & where humans consume raw watercress (Europe, Middle East, Asia) | SE Asia and Japan | Worldwide; especially Great Lakes region (Michigan) |
| **Treatment/Prevention** | * Triclabendazole * Prevention—freeze veggies below -10 C or heat above 60C | * Praziquantel | * Praziquantel * limit waterfowl * treat w/ molluscicides |

* **Helminths**
  + ENDOPARASITES
    - PLATYHELMINTHS (FLAT worms—PLAT is FLAT)
      * Cestodes (tapeworms)
      * **Trematodes (Flukes)**
        + **are flatworms (Platyhelminthes)**
        + **ALL trematodes infect tissue**

**Transmitted by ingestion**

**Fasciola hepatica**

**Paragonimus Westermani**

**Transmitted by contact**

**Schistosoma japonicum, mansoni, and haematobium**

**Wander worm**

**Schistosoma Cercaria dermatitis is also a fluke that causes tissue infection by contact**

* + - * + **NO transmission in USA but immigration, tourism, military make it important, major contributor to morbidity in DALYs**
        + **Characteristics**

**oval, leaf shape unsegmented flat body**

* + - * + **blood flukes (adults in portal drainage) schistosoma sp have separate sexes**
        + **lung flukes, adults in lung paragominus sp are hermaphrodites**
        + **liver flukes (adults in liver or bile duct) fasciola sp are hermaphrodites**
    - NEMATHELMINTHES (ROUND worms)
      * Nematodes
        + Lympatic filariasis
        + Hookworm
        + Trichuriasis
        + Ascariasis

1 in 5 ppl on Earth have this

* + - * + Onchocerciasis

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| ANTIHELMINTHS | | | | |
| DRUG | INDICATIONS | MECHANISM OF ACTION | ADVERSE EFFECTS | SPECIAL NOTES |
| Ivermectin | -Drug of Choice for Strongyloidiasis and onchocerciasis  -Also active vs. intestinal nematodes | -opens Cl- sensitive channels associated with GABA transmission  -causes paralysis of peripheral muscles  -in onchocerciasis it is microfilaricidal (but does not kill adult worms) | -Infrequent, mostly host response to dying microfilariae  -N/V/D, pruritis, rash, edema, joint/muscle pain, etc. | -avoid other drugs that alter GABA activity during treatment (i.e. barbiturates) |
| Malathion | -Head lice and nits | -organophosphate insecticide |  | -note that organophosphates cause cholinergic overdose symptoms if abused/accidentally overdosed |
| Permethrin | -Pediculus humanus, pthirus pubis and Sarcoptes scabiei | -synthetic insecticide acting on parasites nervous cell membranes | - transient burning, pruritis and stinging at application site |  |
| Lindane | -Scabies  -also used as an insecticide  -recommended as a second line agent due to toxicities | -organochlorine compound | -seizures, CNS toxicity and aplastic anemia have been reported | -Available in shampoo and lotion formulations |
| Praziquantel | -Schistosome infections  -most trematodes (flukes) and cestodes (tapeworms) including cysticercosis | **-increase calcium permeability of trematode and cestode cell membranes**  -results in net loss causing worm paralysis, dislodgement and eventual death | -common and transient  -N/V/D, pruritus, lethargy and fever | -schistosome **symptoms may initially become exacerbated** probably due to proteins released from the dying worms |
| Diethylcarbamzine | -Drug of choice for filariasis, loiasis, and tropical eosinophilia | -**immobilizes microfilariae**, alters surface structures and **displaces** them from tissue  -increases phagocytosis as a result of displacement  -mode of action against adults is unknown | -generally mild and transient  -malaise, anorexia, weakness, N/V/D, etc  Later:  -lymphangitis and local swelling with W. bancrofti or B. malayi infections as parasites die | -caution in use w/ hypertension or renal disease |
| Pyrantel pamoate | -broad spectrum  -alternative to mebendazole for Ascaris, hookworm or pinworm | -neuromuscular junction actions- increase Ach release and inhibit cholinesterases (**net increase in Ach signaling**) | -infrequent, transient, mild  -N/V headache and rash |  |
| Niclosamide | -**Second line** drug vs. tapeworms (after Praziquantel) | -rapid killing of worms by **inhibition of oxidative phosphorylation** | -Infrequent and transitory  -N/V | -Avoid EtOH |
| Benzimidazoles | **-Broad spectrum vs. helmithes**  -Intestinal nematodes:  Ascaris lumbricoides, Necator americanus (Hookworm), Strongyloides, Trichinella spiralis, Enterobius vermicularis (pinworms), Trichuris (whipworm), all cutaneous/visceral larval stages  -Adjunct therapy for Echinococcus  -Albendazole for taenia solium | -**bind beta tubulin and inhibit microtubule synthesis**  -also larvicidal in hydatid disease, cysticercosis, ascariasis and hookworm infections | -mild epigastric pain, N/V/D  -long term albendazole is well tolerated but can induce elevated transaminases, pancytopenia, alopecia, fevers, & fatigue |  |